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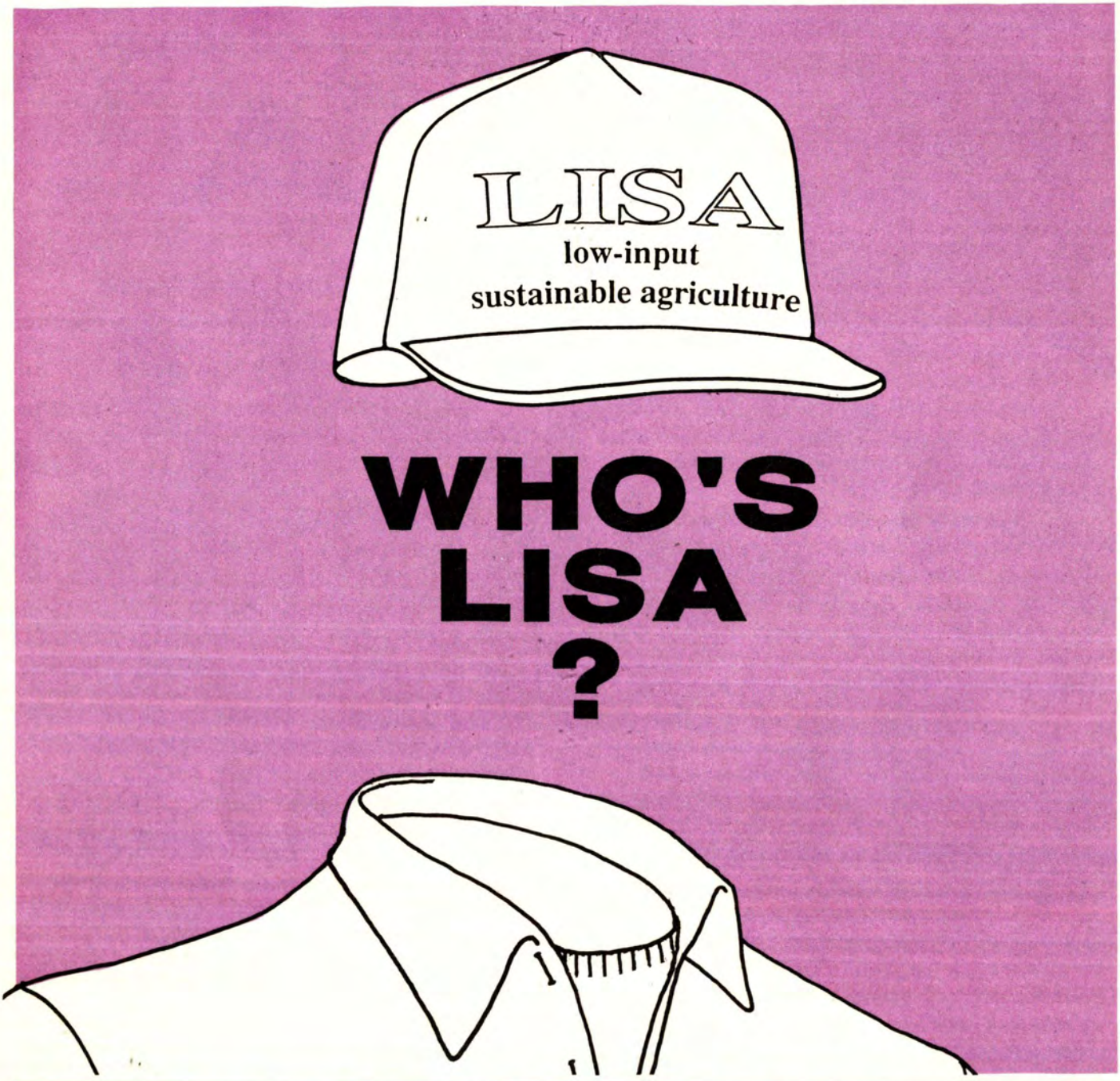

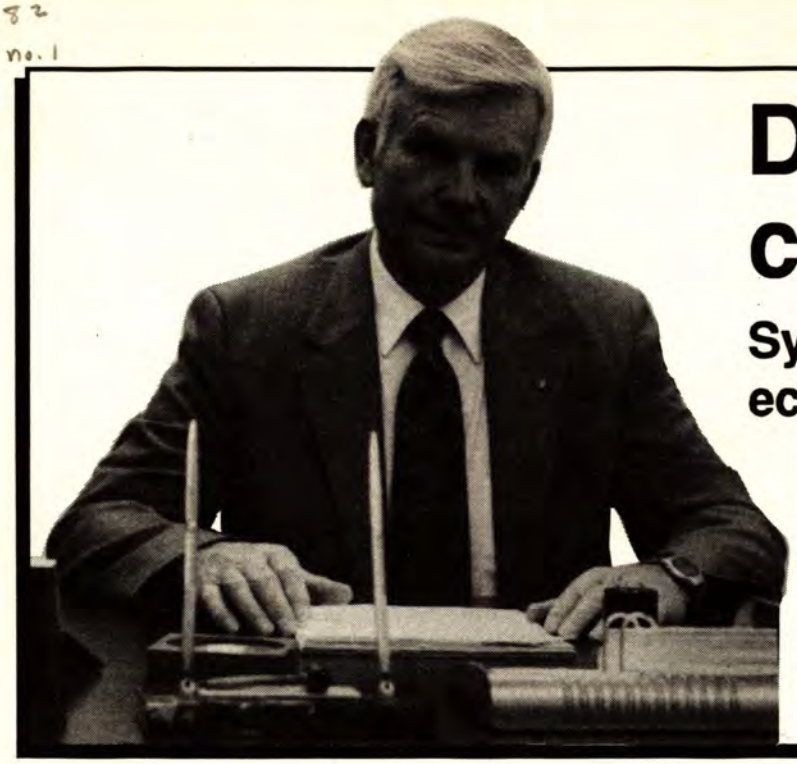

Director's comments

Systems approach meshes economics and ecology

Ray Moore
Agricultural Experiment Station

I bear the label "senior scientist." (You can tell by the color of the hair.) I've learned what others my age learn: What goes around usually comes around.

In the early 40s, our dads used crop rotations to control weeds and crop diseases and pests. Then after WW II came higher yielding varieties. Ag production climbed rapidly, but so did "pest production." So we turned to chemicals. Crop yields took another jump upward. So did the use of pesticides.

For a while, everything worked. Detection procedures showed no problem with food safety. There were some complaints about pesticide residues, ground water pollution, and even worker health and safety, but these problems appeared to be necessary tradeoffs for maximum food production.

But newer, more sophisticated detection instruments came along; occasionally, contamination was found in foods that we had believed safe. Chemicals were implicated. So ag scientists initiated the systems approach to pest control--Integrated Pest Management (IPM) and Low Input Sustainable Ag (LISA).

And that brings us around again. Crop rotation is a part of those systems. One of the reasons for the revived popularity of rotations is the same as in the 40s: Cycling crops often prevents pest outbreaks.

The integration of economics and ecology is the basis of a systems approach. You can't always see that connection right away. Most of the articles in this issue of *Farm & Home Research* report our work in LISA. One of them, about a group of fungi with a tongue-twisting name, seems a little far from weeds or pests or the number of times you make the trip to the elevator.

The connection is there. Certain fungi act like pests in that they invade plant roots and set up housekeeping. But they "pay rent" by supplying mineral nutrients (phosphorus, in particular) to the plant that it wouldn't get by itself. Wouldn't you bet there's a connection with cultural practices and crop sequence?

Our researchers will look next at why crops "infected" with these fungi seem to take off faster in the spring. If the crops get the jump on weeds, wouldn't you also bet that would change your weed control program?

The integration of economics and ecology tends to be overlooked in another systems-approach program.

IPM is more than a scouting program that warns when chemicals are needed. It is a total

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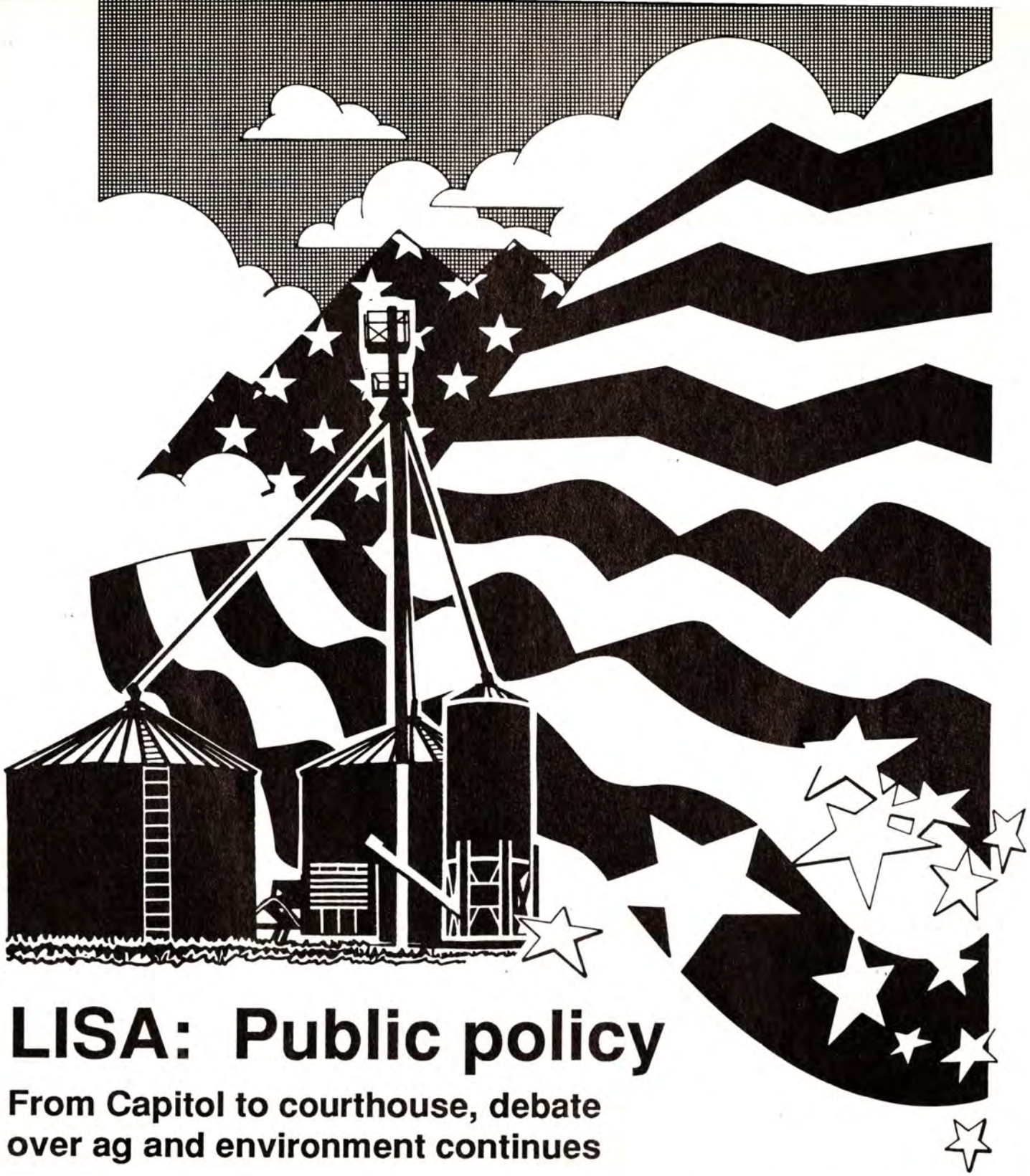


LISA: Public policy

From Capitol to courthouse, debate over ag and environment continues

Environmental concerns are increasingly expressed in our national and state capitols. Policy makers are considering incentives and regulations to foster more environmentally sound agricultural practices.

The policy makers are exploring more restrictive chemical pesticide regulation, special taxes on commercial fertilizers and pesticides, broader and more stringent "compliance" provisions for farmers to qualify for federal farm program benefits, and various changes in commodity components of the federal farm program to modify or possibly even sever the link between direct farm income support payments and crop production levels.

The Food Security Act of 1985 has already

marked a departure from most other recent federal farm bills. The emphases it gives to environmental concerns include the Conservation Reserve Program (CRP), along with conservation compliance and sodbuster and swampbuster provisions. Also included is a provision for expanded research and education on alternative agricultural practices intended to reduce risks of environmental degradation, known since 1988 as the "Low-Input/Sustainable Agriculture" (LISA) program.

Every indication at the present time is that the 1990 farm bill (or extension of the 1985 bill, if that should be the case) will continue and extend an emphasis on environmental quality. It is therefore important that (1) farmer views and (2) information on farm profitability implications of environmental provisions be considered in the discussion and debate.

At the same time, many states and some local governments are considering various forms of environmental legislation relating to agriculture. Concerns about groundwater quality drive much of this movement in the Midwest and Great Plains regions.

Another article in this issue of *Farm & Home Research* describes the farming practices and management strategies of 22 sustainable farmers in South Dakota. Twenty-one of those 22 farmers responded to a set of questions about federal, state, and local policies toward sustainable agriculture when they were interviewed during early 1989. Their responses are of special interest in light of the debates regarding the shape of the 1990 federal farm bill.

"What **changes in the federal farm program** (if any) would you like to see to make it more supportive or encouraging of sustainable agricultural practices?" brought responses which can be broadly categorized as follows, with the number of such responses shown in parentheses (some farmers gave responses in more than one category):

Allow greater flexibility in crops grown (e.g., legumes included in crop rotations) without losing feed and food grain acreage "bases" (7).

Introduce new or stronger conservation/environmental compliance requirements and/or incentives (7).

Largely eliminate the current kinds of federal commodity programs and concentrate on such things as multi-year land retirement and price stabilization (7).

Target federal farm program payments to family-size farming operations (3).

Provide more funding for research on sustainable agriculture (2).

Examples of statements made by farmers urging **greater flexibility in crop acreage requirements** of commodity programs follow (paraphrased):

It is difficult to remain flexible with rotation schedules while maintaining my corn base. I lose base every year because of sweet clover acres.

To encourage proper crop rotations, limit the corn acreage bases on each farm to 30-40% of total cropland, regardless of crop history.

Broaden the list of crops that are supported.

Focus the federal farm program on encouragement of crop rotations rather than on higher yields.

Guarantee no loss of income for one year if a legume is grown in place of wheat (or other cereal grain).

Farmers urging greater attention to **conservation/environmental compliance** requirements or incentives made such statements as the following:

Require farmers to use certain regenerative agricultural practices as a condition for receiving government payments.

Provide incentives for time-honored, proven, naturally regenerative practices such as strip cropping, clover under-sowing, uncompromised crop rotations, and tree planting.

Pay farmers who do not use synthetic fertilizers and other agricultural chemicals.

Restrict the use of synthetic chemical inputs.

Illustrative **substantial changes in the nature of federal commodity programs** suggested by farmers are:

Do away with federal commodity

programs and, instead, involve the government in tax and credit issues. Provide a cover crop payment for up to 25 to 30% of the cropland on a farm; the payment would be for acres planted to regenerative crops (e.g., alfalfa, rye, clover), and farmers would be allowed to hay or graze those crops.

Expand the Conservation Reserve Program to all classes of soil or extend the Acreage Reserve Program from 1 year to 3 to 5 years. These policies would encourage land regeneration and would support commodity prices.

Targeting farm program **payments to family-size operations** was among the concerns of three farmers. Their feelings were expressed as follows:

Gear payments toward moderately sized farms or have smaller payment limitations.

Provide no federal aid to farmers operating more acres than the average for their county.

Limit government payments to $50,000 per farm, based on the 1910-14 dollar. No payments should be made for produce representing more than 50% of the proven production capacity of the farm.

Two farmers also mentioned the importance of **more research** and information dissemination--such as at land-grant universities--on sustainable agriculture. The USDA's new LISA program was cited as a start in efforts to meet this need.

It is not surprising that these 21 sustainable farmers proposed a variety of federal farm program initiatives entailing **greater environmental focus**. However, recently released findings of a different SDSU survey also indicate rather **broad-based** farmer support for stronger federal farm program conservation and environmental policies.

Dr. Larry Janssen* reports substantial support (64 to 70%) among 490 respondents to a February-March 1989 random sample survey of South Dakota farmers and ranchers for, and relatively little opposition (15-20%) to, the following three major environmental policy issues:

(1) Soil conservation and water quality compliance should be a condition for receiving farm program benefits. (2) Government should regulate certain farming practices and land uses to reduce pollution of underground and stream water. (3) Federal farm policies need to give greater encouragement than they do at present to reduced use of synthetic chemical fertilizers and pesticides.

" It is not surprising that these 21 sustainable farmers proposed a variety of federal farm program initiatives entailing greater environmental focus . However, recently released findings . . . also indicate . . . broad-based farmer support for stronger federal farm program conservation and environmental policies. "

Action by state and local governments was also suggested. The 21 sustainable farmers were asked, "Are there things you think state or local governments should do to encourage or require agricultural practices that are more sustainable?"

Those who responded "yes" (16 of 21) were asked for explanations, which are categorized as follows (again, the numbers of such responses are shown in parentheses and some farmers gave explanations in more than one category):

Expand education on alternative farming practices and improve the knowledge level (concerning alternative practices) of Extension agents and local weed supervisors (8).

A label--conventional, "organic," semi-organic, whatever--doesn't necessarily define which farmer is more concerned about environmental fragility. Farmers in general are coming to believe that soil conservation and water quality compliance should be a condition for farm program benefits and that the government may have to regulate land uses to reduce groundwater pollution.

Provide stronger environmental quality controls and incentives in such areas as spray drift and groundwater contamination (7).

Encourage or require more university research on sustainable agriculture practices (2).

Various other responses included lowering land taxes, providing livestock loans, providing more recognition for good land stewardship, and establishing a state (South Dakota) "organically grown" certification label (5).

Half of the farmers who think state or local governments should take actions to encourage sustainable agriculture mentioned **education**. Suggestions (paraphrased) include:

People need to be educated about underground water contamination.

Education is needed on the harmful effects of chemicals.

Information should be provided on alternative forms of weed control.

Extension agents need to know more about sustainable agriculture.

Nearly as many farmers (7) also mentioned state or local initiatives in the area of **environmental quality controls or incentives**. Examples of their suggestions follow:

Strengthen and enforce laws regarding spray drift and application of chemicals on windy days.

Stop ditch spraying by local governments and leave that responsibility to the property owners.

Penalize those who poison the air, water, crops, and land. However, we must be careful with laws, as they could be another way of driving small farmers off of the land.

Monitor groundwater contamination and soil erosion.

Strictly enforce groundwater laws and ordinances.

Two farmers listed more **research on sustainable agriculture** as a state initiative. One went so far as to say that all research institutions should be forced to spend as much money on sustainable agriculture research as they do on conventional agriculture research.

SDSU researchers are in the process of analyzing a variety of policy options which have been suggested by farmers and others to encourage expanded use of sustainable practices. Data from farmer interviews and other sources are being used to develop models for whole-farm economic analyses of policy options. The implications of various policy options for (1) net income earned from farming and (2) incentives to expand the use of "sustainable" production practices will be determined. □

The authors are Dr. Thomas L. Dobbs, David L. Becker, and Dr. Donald C. Taylor, professor, research assistant, and professor, respectively, in the SDSU Economics Department. *The research reported here is supported by Grant No. 88-56 from the Northwest Area Foundation (NWAF) in St. Paul, Minn, and by the SDSU Agricultural Experiment Station. Principal investigators in the NWAF project are Dobbs (overall project leader) and Taylor in the Economics Department and Dr. James D. Smolik in the Plant Science Department. For more details on policy findings from the on-farm interviews conducted in 1989, please request a copy of* Farm Program Participation and Policy Perspectives of Sustainable Farmers in South Dakota *(17 pp, $1.50) from Sustainable Agriculture, SDSU Economics, Box 504A, Brookings, SD 57007.*

**Janssen, L. Agricultural Policy Decisions: Perspectives of South Dakota's Farmers.* Econ Commentator *275. Brookings: Econ Dept, SDSU, Sept 15, 1989.*

LISA: Soils and yields

When it won't rain and soil runs dry, LISA farming may be your best bet

Many farmers suspect that chemicals create the need for ever more chemicals as the years go on.

They also suspect that public sentiment to protect groundwater from non-point pollution will become organized to the point of limiting or even curtailing chemical application.

They wonder if LISA, low-input sustainable agriculture, is the answer to both problems.

Preliminary results (from SDSU research begun in 1985) indicate that alternate farming systems without commercial fertilizers or pesticides and without the moldboard plow can compete with conventional systems.

But the environment still had the upper hand. Growing season precipitation was the major factor influencing yields of nearly all the crops in the 5-year period (1985-1989).

The edge went to LISA farming in drought years when plants were stressed by lack of water. At the Northeast Station, where this research was done, LISA yields dropped in 1988, but usually less and never more than did yields of conventionally farmed crops. With less input costs, net income was higher.

Conventional (C), LISA (A, for Alternate), and ridge-till (R) systems were begun in 1985 at the Northeast Research Farm near Watertown on a Brookings silty clay loam classified as a Pachic Udic Haploboroll.

Crops chosen for the systems represented the dominant crops of northeastern South Dakota. The A system, for example, is used by alternative (sustainable) farmers in the area (Table 1).

These are the results of one complete rotation cyle. We'd be happier if we had data from two or more rotation cycles, but some trends are beginning to emerge.

In the 4-year A system (oats-alfalfa, alfalfa, soybeans, corn), we used alfalfa to reduce weed problems, to interrupt disease

and insect cycles, and to provide nutrients for crops that followed. The stand was maintained for one year past the establishment year.

The alfalfa stand was harvested for only one year because 4- or 5-year-old alfalfa stands (for hay crops) can deplete soil moisture and encourage perennial weeds, thus limiting the yields of following crops. Older stands are also more subject to foliar, root, and crown diseases, nematodes, and weevils, and they may be more difficult to incorporate without using a moldboard plow.

Feedlot manure was applied in the fall to the oats-alfalfa plots. Alfalfa forage was harvested three times the following year. In most years, alfalfa was incorporated by undercutting followed by chisel plowing.

Soybeans, rather than corn which requires more water, followed the alfalfa in the rotation. Since soybeans are also planted later in the spring than corn, the soils have a chance to store any early spring rainfall. The later planting also allows a later preplant tillage for weed control. Corn was the last crop in the rotation.

No commercial fertilizers or pesticides were used.

The C (conventional) system was a 3-year rotation of corn, soybeans, and spring wheat. Recommended rates of herbicides were used, and soils were fertilized according to soil tests.

Corn stubble was generally disked in the fall, and a field cultivator and disk were used to incorporate herbicide prior to soybean planting. Soybean stubble was not tilled in the fall; it was disked or field cultivated prior to wheat planting. The wheat plots were moldboard plowed after harvest.

The R (ridge-till) system also was a 3-year rotation of corn, soybeans, and spring wheat. Again, we used recommended rates of fertilizer and herbicides. Corn was ridged at second cultivation (except in 1986 when wheat stubble was ridged in the fall). Soybeans were planted on existing ridges but not ridge cultivated. The next year's wheat was then planted on nearly level ground.

The ridge rotation was developed for farmers who want to use ridge-till as a soil conservation practice but who have small grains in their rotations.

In all systems, we planted all crops in each rotation each year. In most years, all row crops in all systems were cultivated twice, and in the A system, row crops were also rotary hoed twice.

" Preliminary results . . . indicate that alternate farming systems . . . can compete with conventional systems. "

Precipitation was well above normal in 1985 and 1986, near normal in 1987, and well below normal in 1988 and 1989. In 1987, soil water declined as the season progressed and crop demands increased. In 1988, soil water levels dropped to critical levels during the summer drought but increased with fall rainfall. Spring 1989 soil water rebounded but again decreased with crop removal and limited summer rainfall.

The A oats-alfalfa residue caught more snow than all other treatments, and soil water levels in the springs of 1987 and 1989 were greater in the following alfalfa than in other A crops. By mid-July, the differences in soil water were no longer significant.

In the C system, there was a general tendency for soybean soils to have greater soil moisture than spring wheat soils. R systems showed no relationships between crops and soil moisture levels.

Soil water under spring wheat was greater in the C than in the R system in only one case. The 0-15 cm depth in the fall of 1988, when harvest was followed by rainfall, had higher soil water when the wheat stubble was turned with a moldboard than when chiseled. This difference did not last until spring.

We could not detect any differences in soil water among the systems for soybeans and corn.

When soil-water content was averaged across years, April values were not significantly higher for any system. By mid-July, soil water reflected crop use, and spring wheat nearing maturity was removing more water than the row crops. Spring wheat in the R system had less water than C spring wheat.

Table 1. Crop rotation and fall primary tillage in each system during 1986, 1987, and 1988.

System	Crop Rotation	1986	1987	1988
		--- Primary Tillage ---		
Alternate	Oat/Alfalfa	none	none	none
	Alfalfa	chisel	chisel	chisel
	Soybean	none	none	none
	Corn	disk	disk	disk
Conventional	Corn	none	disk	disk
	Soybean	none	none	none
	Spring Wheat	moldboard	moldboard	moldboard
Ridge	Corn	none	none	none
	Soybean	none	none	none
	Spring Wheat	fall ridged	chisel	chisel

Fall soil water, when averaged for 1987 and 1988, was the same in all systems.

Crop residues ranged from 100% coverage of the soil surface in the oats-alfalfa to 6% in plowed wheat stubble. The chisel plow in the wheat left significantly more surface residue than the moldboard. Ridging left higher row-crop residues than the C treatments.

Over the years, only the amount of residue left by the oats-alfalfa was sufficient to insulate the soil and decrease spring soil temperatures.

Mid-July soil temperatures were the reverse of differences in soil water content. When averaged over 2 years, soil temperatures were highest in small grain, followed by corn, and lowest in soybeans.

Corn grain yields were greater in R and C systems than in A in 1986 and 1987 but were less than A in 1988 during the height of the drought.

Soybean yields were highest in A, followed by C, and then R. Spring wheat, not grown in the A system, had higher yields in C than in R.

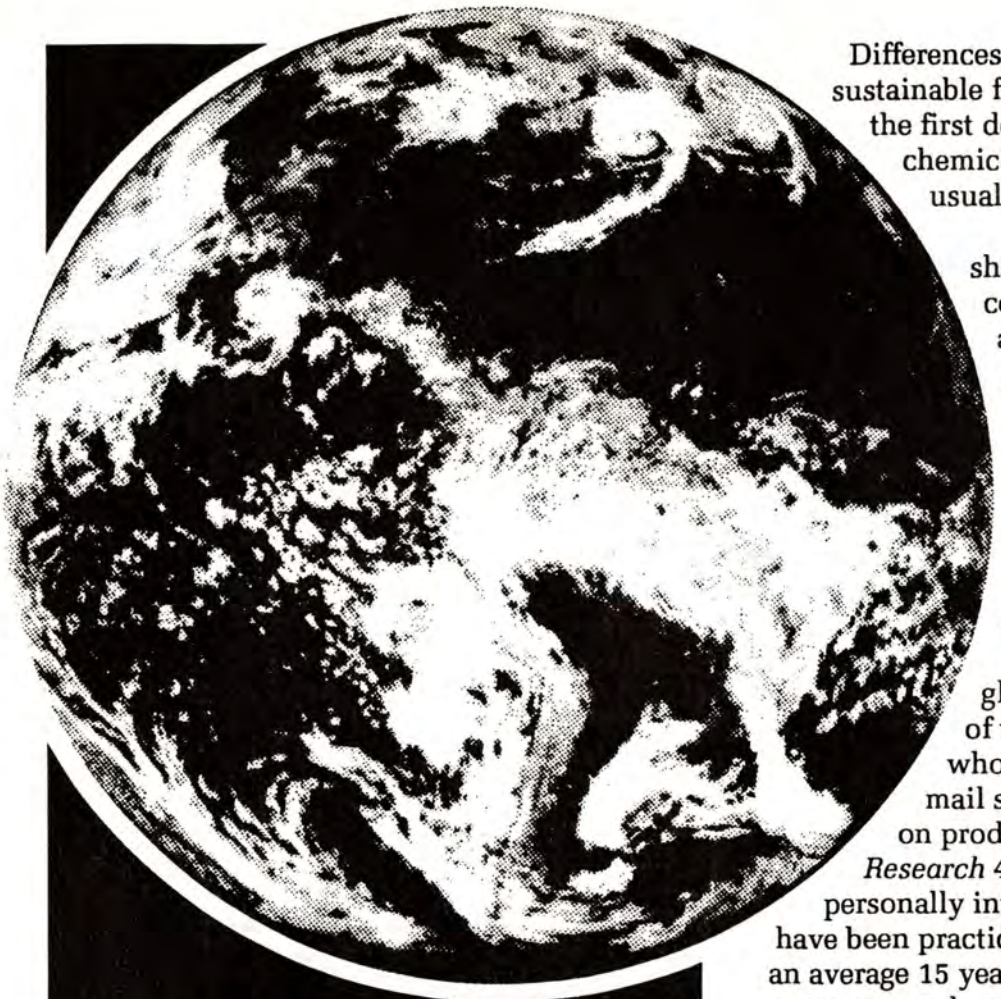
Soil water contents seemed to relate to the year's precipitation and a specific crop rather than to alternate, conventional, or ridge-till systems. Soil water was always lower in small grains nearing maturity than it was in row crops, regardless of the system. No one system retained more soil water than any other.

Crop residue and its influence on soil temperature were also dependent upon crop and tillage rather than on system. Heavy residues on the surface kept soils cool and moist in the spring. The 3-year spring soil temperature averages indicated that heavier corn residues in the A system, for example, did not influence soil temperature differently than corn residues in the C system. By mid-July the main effect was no longer residue but crop growth.

Most interesting to us was that corn yields in the A system overtopped all others when crops were drought stressed. This aspect of a LISA system can be the difference between income and loss in an area where rainfall is limited.

Economic analyses by Dr. Tom Dobbs and Clarence Mends in the SDSU Department of Economics indicated that returns in the 1988 drought year were approximately five times greater in the alternate than in the conventional and ridge-till systems. Thus, the alternate system's greatest advantage may be in limited rainfall areas. □

The authors are Dr. Diane Rickerl and Dr. Jim Smolik, assistant professor and professor in the Plant Science Department at SDSU.



LISA: In the 'real world'

Veteran producers report how they farm and the risks they encounter

"Sustainable agriculture," as we use it in this article, starts with a reduced use of commercial fertilizers and pesticides on the farm. Most other ways in which sustainable agriculture differs from "conventional" farming--the differences in crop rotations, in livestock enterprises, in risks and managerial strategies--stem from the lower chemical inputs.

Differences between conventional and sustainable farming are cumulative--when the first decision is made (to lower chemical use), other decisions usually follow.

Consequently, there is no sharp dividing line between conventional and sustainable agriculture, no point at which we can say, "now this person is practicing low-input ag." Farmers using sustainable practices may indeed use some chemicals. Or they may not. Sustainable farmers are as individualistic as any other set of farmers.

This article provides a glimpse into the decisions of 22 of the 32 sustainable farmers who participated in an earlier mail survey ("Sustainable ag: Focus on producers," *Farm & Home Research* 40(1):15). The 22 were personally interviewed in early 1989. They have been practicing sustainable agriculture for an average 15 years each, which validates their responses and opinions, since they have been through at least two to nearly four complete crop rotations.

Not all of the 22 farmers are "organically pure." Ten are "totally crop organic." They use no synthetic chemical fertilizers or pesticides on any of their cropland. Another five have "organic" crop rotations but also use some synthetic chemicals on some cropland. Seven use reduced levels of synthetic chemicals on their crops but have not completely eliminated the use of chemicals on any of their cropland.

In general, their rotations tend to contain small grains, forage legumes, and row crops.

The relative incidence of these crop types in particular rotations, species and varieties, and the use of summer fallowing differ for different farmers. This is no surprise. Soil types and other growing conditions vary as much for sustainable farmers as they do for conventional farmers.

Small grains are included in **all** crop rotations on the sustainable farms.

The most common small grain is oats (in 68% of the rotations), followed by spring wheat

(50%), rye (46%), and millet (32%). At least one row crop is found in 20 of the 22 rotations, with soybeans (77% of the rotations) and corn (66%) being the most common row crops.

Seventeen rotations have alfalfa and one has red clover. After the establishment year, alfalfa is most commonly harvested for 4 to 5 years (8 rotations). Four farmers harvest alfalfa 2 to 3 years, and two for 6 to 7 years. Two farmers harvest alfalfa for only 1 year, minimizing the alfalfa's impact on soil moisture depletion while maximizing its impact on weed control.

Twelve rotations involve at least 1 year of summer fallowing. A cover crop (most commonly sweet clover, but sometimes forage sudan) is used by seven farmers and black summer fallow by five. Two farmers rest their land every 7th year, one under cover of forage sudan and sweet clover and the other under cover of matured weeds. Three of the 22 rotations also involve a spring plow-down of sweet clover seeded the previous fall.

We can make some generalizations on how sustainable agriculture is practiced in different regions (see map). Remember that these observations are based on only 22 participants.

In the south-central region, as compared to the other surveyed regions, cropland acreages are relatively small (an average of 425 for seven farms).

The rotations are rather evenly balanced between small grains and row crops. Harvesting of forage legumes is important.

Sustainable farmers practice limited summer fallowing with cover crops (two of seven).

In the east-central region, cropland acreages are also relatively small (an average of 535 for seven farms).

Rotations are relatively simple, with a rather definite orientation to a pattern of soybeans-corn-small grain-forage legume.

Row crops are slightly more prominent than in the south-central region, and far more important than in the west.

Harvested legume forages are slightly more important than in the south-central region. Alfalfa is harvested for fewer years than in other regions.

There is relatively limited cover-crop summer fallowing.

In the northeast region, cropland acreages are intermediate in size (an average of 760 for five farms).

Small grain-summer fallow is a fundamental component of rotations; soybeans are present in all rotations.

The extent and diversity of small grains is greater than in other regions. Four of five farms have either spring or winter wheat and both rye and millet.

Black summer fallowing is common (three of five rotations).

Forage legumes are less important than in the south-central and east-central regions.

" Farmers using sustainable practices may indeed use some chemicals. Or they may not. Sustainable farmers are as individualistic as any other set of farmers. "

In the west region, the cropland acreages are largest of all regions (an average of 1,500 for three farms).

Small grain-summer fallow is a component of all rotations.

There is more intensive (frequent) fallowing than in other regions. Two of three rotations have black fallowing.

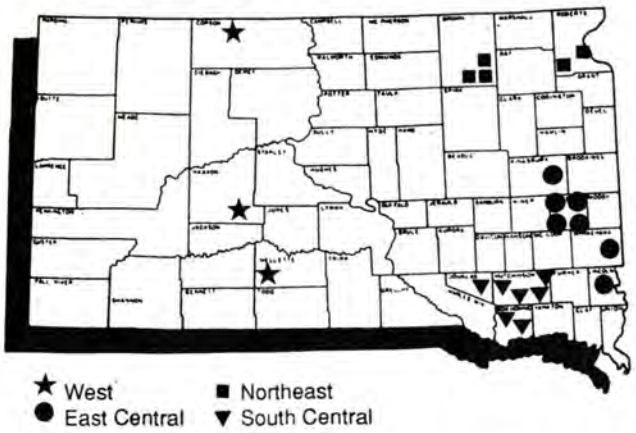
Row crops are not present in the rotations of farmers interviewed.

From preplant land preparation through postharvest, all of the farmers performed an average of nine cultural operations on both corn and soybeans. This includes averages of 2.7-2.8 field tillage and 3.9 weed control operations per year per crop.

Fifteen of the 16 farmers cultivate both corn and soybeans for weed control. Two to three cultivations per season are most common for corn; two cultivations are most common for soybeans. The second most common type of mechanical cultivation in corn and soybeans is the rotary hoe.

Averages of between 5.9 (for winter wheat) and 7.9 (oats) cultural operations per year are performed on the main small grains. There are about the same numbers of field tillage operations as in row crops, but fewer for weed control.

Map 1. Location by region of sustainable farmers interviewed.



Ten farmers use the moldboard plow. All of them use it to incorporate alfalfa or sweet clover. Two also plow following small grain, and one following the application of an organic soil conditioner on soybean ground.

Eighteen farmers have commercial livestock enterprises. The most common is a cow-calf operation; next is cattle finishing. Herd sizes on the sustainable farms average about half the state average of 79 cows per farm. Less than a fourth of the farms have hog farrowing, hog finishing, or dairy enterprises.

Fourteen of the 18 farmers with livestock believe they raise their livestock sustainably; two follow a combination of sustainable and conventional practices; and two do not follow sustainable practices.

Livestock management practices viewed as "sustainable" by a majority of the 14 farmers are (1) feeding only organically grown grain and roughage to livestock; (2) greater reliance on roughages, relative to grains, to finish cattle; and (3) no antibiotics or other additives in concentrate feeds, no hormones or other growth stimulant/promotants or insecticides, and no vaccinations or closed confinement facilities.

All 18 farmers with livestock report using all the manure they produce on their farms. Two also obtain manure from neighbors.

Nevertheless, manure applications to cropland are limited. For example, six farmers report covering 5% or less of their cropland once with manure during one crop rotation. Three farmers apply manure to between 6% and 20% of their cropland. Crop rotations on these nine farms range in length from 4 to 7 years.

The three farmers who make the heaviest manure applications cover the following percentages of their cropland once each 3 years: 30%, 50%, and 60-75%.

In amount of **risk** a sustainable farmer encounters, 11 farmers perceive sustainable agriculture to involve less risk than conventional agriculture, three more risk, two both more and less risk, and five see no difference.

Based on farmers' responses, we conclude that sustainable agriculture may be more risky than conventional agriculture from several standpoints:

Since the transition from conventional to sustainable farming involves a general venture into the "unknown," risks can initially be expected to increase, specifically with (1) expanded weed and other pest problems and (2) nitrogen shortages.

Since federal farm programs do not exist for legume forages and most livestock products integral to many sustainable farm operations, "government price guarantees" for grain farmers participating in the farm program are not as available to a more diversified sustainable farmer.

Since "organic" product markets are thin, sustainable farmers who choose to sell their products "organically" may experience greater risks of product price instability.

Since wholesale organic product buyers generally do not purchase and take possession of organic produce from farmers until the buyers have found markets for the produce, cash-flow problems may be experienced by sustainable producers.

Since some lenders do not have confidence in sustainable agriculture, such farmers may be less able to secure credit.

On the other hand, risks in sustainable agriculture can be less than with conventional agriculture from several standpoints:

Since sustainable farmers often have a more diverse set of crop and livestock enterprises, these operators may be cushioned from adverse growing conditions and/or adverse product price movements.

Since sustainable farmers commonly have livestock that utilize relatively low-value feedstuffs, they often can expect less of an economic disaster if their row and forage crops fail to properly mature.

Since sustainable farmers purchase fewer off-farm inputs than their conventional counterparts, they lower the risk of being unable to meet obligations to their creditors and of having increased production expenses when input prices increase.

" Selling through 'organic' markets is not required of sustainable, or even 'organic' farmers. "

Since soil managed sustainably has improved structure and organic matter content and, hence, has better soil water-holding capacity, sustainable farmers have less risk of crop production disaster during drought or of exaggerated soil erosion during heavy rains.

Since sustainable farm workers handle fewer or no potentially dangerous chemicals, such operators lessen chances of impairing their health.

Since synthetic chemical input use is less in sustainable agriculture, risks of ground and surface water contamination and health impairment to diet-sensitive consumers may be less.

Since the managerial requirements of sustainable agriculture are great, special positive incentives exist for sustainable farmers to become even stronger managers, thereby resulting in their becoming better able to cope with risks and uncertainties.

Managerial strategies can overcome potential problems in sustainable agriculture.

The most common way to control weeds during the transition from conventional to sustainable practices is to use crop rotations that interrupt growth cycles of various weed species.

Forage legumes and other weed-competitive crops (e.g., rye, millet, buckwheat) in the rotations contribute to effective weed control. Other weed control methods are mechanical cultivation and special timeliness of crop planting and cultivation.

The most common way to overcome transitional nitrogen shortages is also the crop rotation. The presence in rotations of legumes for nitrogen fixation and of cover crops and plant residues for plow-down are crucial.

The most commonly reported problem in marketing organic products arises from wholesale buyers not purchasing and taking possession of organic produce from farmers until the buyers have found markets for the produce. As a result, a producer has to bear the burdens of providing and meeting associated costs of on-farm storage for the organic produce and of surviving an uncertain and uneven cash flow.

A second rather common problem with marketing organic produce concerns the distance from producers to plants where the organic produce is cleaned and assembled for shipping.

Selling through "organic" markets is **not** required of sustainable, or even "organic" farmers. Most of the farmers in these interviews weighed the higher prices they would receive in an organic market against the difficulties of moving produce to that outlet and have elected to sell commercially in the same market used by their conventional farmer neighbors.

]The sustainable producers believe the highest priority research need in sustainable agriculture is the comparative testing of sustainable and conventional crop rotations. Suggested focal points in such work are soil fertility, soil structure, soil microbial activity, and weed control.

The most common thread in their responses on how they, private organizations, and universities can work most effectively with each other is that "each one should keep an open mind." It is not in agriculture's best interests, they warn, to automatically assume that any one farming method is necessarily better or worse than another. □

The authors of this update on sustainable agriculture are Dr. Donald C. Taylor and Dr. Thomas L. Dobbs, professors of agricultural economics, David L. Becker, economics research assistant, and Dr. James D. Smolik, professor of plant science. *The research was supported by the Northwest Area Foundation, St. Paul, Minn., and the South Dakota Agricultural Experiment Station.* *For more details on these and other findings from the personal interview survey, please request a copy of* Crop and livestock enterprises, risk evaluation, and management strategies on South Dakota sustainable farms *(103 pp, $6.00) from Sustainable Agriculture, SDSU Economics, Box 504A, Brookings, SD 57007.*

LISA: Friendly fungi

The farmer has underground enemies and allies. Among the 'good guys' are VAMs

Above ground, there's only the crop to see. Leaves may be moving in the wind, but that's about the only break in the monotony.

Underground, it's a different story. Among the crop's roots are soil inhabitants whose appearance and activities could, without much added imagination, be the subjects of late-night "horror flicks."

From our point of view (tempered by economics) some of these soil micro-organisms are harmless, some are helpful, some are severe parasites of economic crops. Among the micro-organisms are certain fungi in a group as complex as its name, the "vesicular arbuscular endomycorrhizae" (VAM).

They infect plant roots, but they improve yield.

In infection, they stop short of actually causing disease (killing cells and tissues in the host plant). The host plant, instead, usually gets around to quarantining the infected spots and digesting the invader.

But not before it has gotten some yield-increasing benefits from the fungus.

Plant roots of nearly all annuals and perennials are infected by VAMs. The VAMs do not disrupt or digest the root cells that they invade; in return for carbon from the root, they provide minerals, in particular, phosphate, from the soil. It's been shown that VAMs are better at collecting mineral nutrients from soils than are the root hairs of uninfected roots.

If healthy VAMs can collect phosphorus from the soil and turn it over to the crop plant, perhaps we should encourage the fungi. Both tillage and crop sequence influence soil microbes, including the VAMs.

So we were curious about what was happening in the alternate (A), conventional (C), and ridge-till (R) plots in the LISA experiments at the Northeast Farm (see accompanying story for research design). In early summer and in the fall we collected sample plants from the plots and examined the roots in the lab for mycorrhizal infection.

Top growth production of dry matter varied among crop and system. C corn produced more dry matter in early July, but by September A corn had passed the C corn. R corn lagged behind at both dates. Root growth showed no significant differences within crops due to system.

Corn generally had a greater percent of root length infected with mycorrhizae than other crops, especially in the A system on the first sample date. Lack of commercial fertilizers and pesticides and the tillage system employed in the A system may have favored conditions for rapid colonization of roots by the mycorrhizae.

> ***" If healthy VAMs can collect phosphorus from the soil and turn it over to the crop plant, perhaps we should encourage the fungi. "***

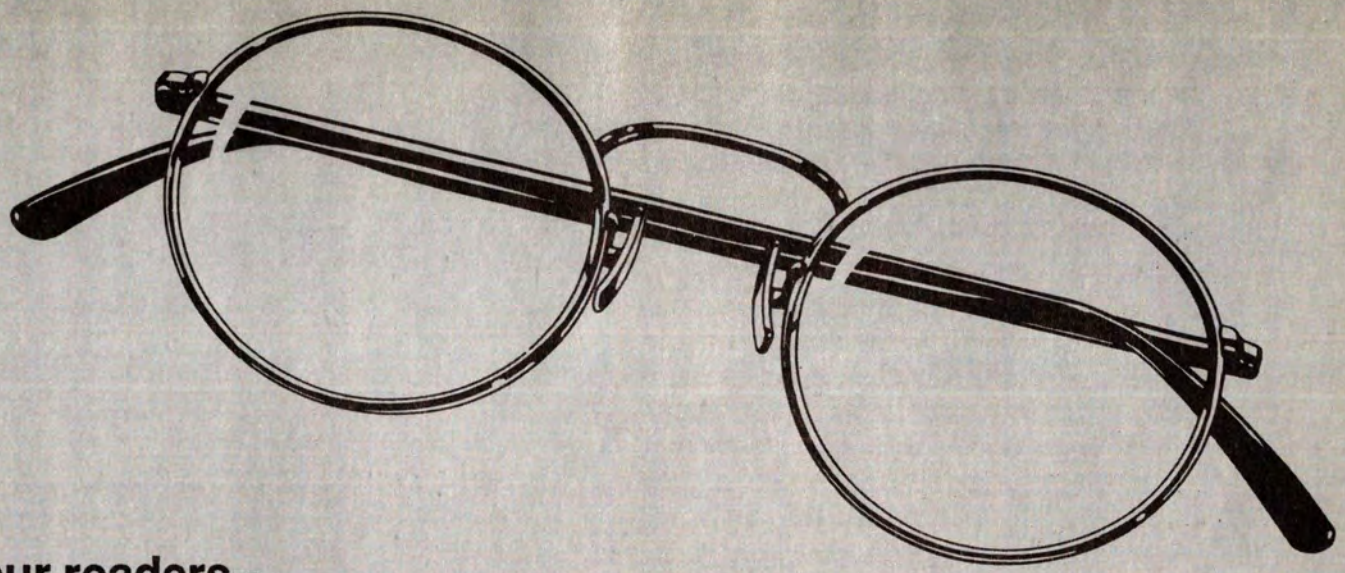
At the second date, corn still had more root length infected than soybeans in the A and R systems. The only difference in infection within crop that was due to the system was between A and C soybeans.

Corn grain yield was significantly higher in the A system (39 bu/A) and in R (31.7 bu/A) than in the C system (19 bu/A). (Remember that 1988 was an extremely droughty year.) The yield corresponded to mycorrhizal infection on the early sample date.

Soybean yield differences among systems were not significant. Spring wheat grain production was greater in the C than in the R system, and this, too, was similar to mycorrhizal infection at the early sample date.

Other research has shown a correlation between early mycorrhizal infection and subsequent grain yield. We will be examining that relationship. □

The authors are Dr. D.H. Rickerl and Dr. J.D. Smolik of the Plant Science Department, SDSU.



To our readers--

The Bulletin Room of the College of Agriculture and Biological Sciences has overstocks of certain publications written by our Agricultural Experiment Station researchers. Some are older titles but still contain useful information.

We are offering these publications to you free of charge until September 1.

At that time we will make other distributions and these publications will no longer be available except through College departments.

If you would like a free copy of any of these publications, please write
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Brookings, SD 57007.
We will be happy to send you the copies you request, while they last.

In Ag Engineering:
B 680, Interseeding and plans for SDSU's new machine for better pasture production (interseeder)
TB 53, Changes in field stored large hay packages

In Ag Economics:
B 649, Commercial bank financing for industrial development
B 650, Local public finance impacts of rural residential development, case study of Rapid City school district
B 652, Pasture systems: economic alternatives
B 653, Grain transportation in South Dakota
B 665, Industrial development financing in South Dakota
B 658, Gasohol
B 666, Lincoln County rural water system: growth impacts
B 673, Goose marketing and production
B 675, Public impacts of rural water systems: case study
B 676, South Dakota grain production: yesterday and tomorrow
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B 678, Water use by rural manufacturing firms in South Dakota
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C 239, Guidelines for sharing recreation and park facilities and their cost
TB 51, Effects of crop diversification upon variability of income for eastern-southeastern South Dakota
TB 81, Irrigation in Brookings County: an economic study of irrigated corn

In Plant Science:
B 661, Barley in South Dakota: cultural practices, havesting, varieties, utilization, services
B 663, Eureka! (announcement of new HRS wheat)
B 672, Retain (announcement of new creeping foxtail)
B 700, A new oat: Kelly
B 701, A new oat: Hytest
B 702, A new oat: Sandy
TB 47, Linear regression analysis using a programable pocket calculator
TB 48, Calculation of the two-way analysis of variance (ANOVA) using a programable pocket calculator
TB 49, Calculation of the two-way analysis of variance (ANOVA) with subsampling using a programable pocket calculator
TB 50, Calculation of multiple regression with three independent variables using a programable pocket calculator
TB 68, Soils of the wheat taskforce plots
TB 70, South Dakota soybean production: yield and land use trends 1961-1986
TB 90, Winter survival and other agronomic data for winter barley composit populations developed for deep-setting crown characteristics

In Sociology:
B 660, Changing farm numbers
B 679, Native American youth: What are their career interests, career educational needs?
B 690, South Dakota youth: delinquency-prone behavior
TB 59, What do the self-concepts, aspirations, plans of small town and rural youths have to do with delinquency proneness?

Networking senior centers

Keep the small-town warmth, add 'bureaucracy.' Is this the answer?

We all have--or know of--an "Uncle Bill."

Uncle Bill stays away from the senior citizen center.

His real reason for not going may have less to do with an old man's stubbornness than you think. Maybe the center is closed except for a few hours each week. Maybe, when it is open, it only offers bingo, or cards, or bake sales, and he's not into those things.

Local senior centers do the best they can, but they're too often hamstrung by the same things that frustrate so many other programs in South Dakota--low population density, geographic isolation, few resources.

And, oddly enough, in the case of senior centers, by another frustration: not enough bureaucracy.

Senior citizen centers in South Dakota and the Northern Plains might fare better if they kept the warmth and personal attachments of community meeting places but made them part of a network under centralized administration. A survey by the Rural Sociology Department shows that some centers can efficiently offer expanded services because they have reorganized on a county-wide scale.

What our Uncle Bills and other elderly people do with their lives is also our concern. Loneliness, alienation, poor nutrition, lack of attention to medical needs all take their toll in increased stress in the countryside.

Our elders' quality of life has become a political and social issue for the 90s, for three reasons:

First, there are more of them--54% more in the U.S. since 1960. Second, they are living longer, are in retirement longer, and are in better health (usually). Third, they are a mixed group--some are well off, some are poor, some are young (relatively), and some are very old. Consequently, they have a broad range of needs, and no one program will satisfy all.

Since the passage of the Older American Act (OAA) in 1965 and its amendments in the 70s, the "aging network" includes the federal Administration on Aging and state, county, and local aging agencies developed out of the OAA. The aging network includes public agencies, private groups, and voluntary associations. Senior centers are a part of this network.

Some senior citizen centers have moved beyond the activity-and-games concept and now deliver coordinated, formal care to the elderly. Some are "service agencies," with most of their money coming from federal and state governments. They assist elderly people to obtain a variety of health, transportation, and other social care services, and many offer congregate meals. Others are multipurpose senior centers which serve as both activity center and service agency.

To make the jump from senior club to multipurpose center requires an influx of resources (money and professional leadership) that small communities operating independently do not have.

There are 897 senior citizen centers in South and North Dakota, Nebraska, and Montana serving an estimated 510,000 people aged 65 or more. Of these centers, 35 senior clubs, 41 service centers, and 67 multipurpose senior centers participated in this survey.

Senior clubs are places where seniors meet and visit. Service centers add a few social care

The senior center--unstaffed, dependent on the next bake sale for operating funds--still is a jovial, warm gathering place. If it can be part of a "network" of satellite centers and a central service center, it would have more funds, longer hours, and more activities. Uncle Bill might even be lured in for a hand of pinochle.

services. The multipurpose center combines the functions of the other two into a senior club with a broad range of social services.

If Uncle Bill lives in a small town, he probably has only a senior club to visit. Only 24% of rural communities with populations less than 600 people had multipurpose centers; nearly half of all centers in these small communities were senior clubs. In contrast, 65% of urban communities with populations exceeding 12,000 had multipurpose centers.

Surprisingly, there were no significant differences in the number of services that senior clubs and service centers say they offer their members and clientele. If senior clubs truly offer the services they claim, the generosity and devotion of the participants is commendable, since the survey also found that senior clubs are largely run by volunteers, the seniors themselves.

Senior clubs were the least accessible to our Uncle Bills, being open to the public an average 12 1/2 hr/wk. Service centers averaged 31 hours, and multipurpose centers were open, on average, 37 hr/wk.

" Local senior centers ... are hamstrung by the same things that frustrate so many other programs in South Dakota-- low population density, geographic isolation, few resources. "

Senior clubs scraped along on an average $3,400/year, most of it from city government. The average service center operated on $10,600/yr, and the multipurpose senior center had an average income of $85,980/yr (Table 1). Naturally, the bigger center also had more staff and more records to keep.

Bureaucracy comes with growth. Formality assures efficiency in management of programs, personnel, finances, facilities, and equipment.

The ability of a community to offer a broad range of programs is limited to the number of resources it can muster. The most important is money, but so is the potential number of elderly that will be using the center's programs. Rural communities simply do not have the economies of size necessary to deliver multipurpose programs.

Table 1. Average funds from each source by senior center type.

	Senior clubs	Service centers	Multipurpose centers
	amount in dollars*-------		
Federal government	202	1,270	28,911
State government	0	700	4,331
State mill levy	289	198	1,262
County mill levy	461	761	6,173
City government	1,119	785	6,720
Rent on facility	415	215	3,161
Estates, memorials	134	178	1,847
Membership dues	124	451	2,968
Individual donations	102	491	17,146
Fund raisers	400	3,373	6,095
Other**	160	2,179	7,366
Total	3,406	10,601	85,980

*Rounded to nearest dollar
**Sources not specified by survey respondent.

The multisite satellite senior center implements more efficient delivery systems in rural areas. Around the centrally located multipurpose senior center are satellite sites in neighboring communities.

Satellite sites are more comprehensive than the senior club, because they can afford to offer more services or provide transportation to the central facility. They are more efficient because programs are centrally administered by trained, professional staff.

Some states in the Northern Plains and across the U.S. have put the multisite satellite concept into place by locating at least one multipurpose center in each county.

But when social agency administrators and elderly people in small towns must "go it alone," rural communities will have too few people participating and too few dollars to pay for the range of social care services that federal legislation intended. Uncle Bill won't know what he missed. □

The writer is Dr. Don Arwood, assistant director of the SDSU Census Data Center and assistant professor of sociology.

IMR in Shannon County

Infant mortality rate on Pine Ridge Reservation among highest in nation

South Dakota has one of the **lowest** infant mortality rates in the U.S. for white babies and one of the **highest** for non-white infants.

Infant mortality rate (IMR) is given in deaths per thousand live births during the first year of life. The year is divided into two periods: neonatal (birth to 28 days); and postneonatal (29 days to 1 year). In South Dakota the biggest spread appears in the postneonatal period.

In 1983, the postneonatal IMR for Native American babies in South Dakota was almost six times greater than the rate for white infants. In all other years between 1977 and 1987, the rate for Native Americans was 3 to 5 times higher (Figs 1-3).

Postneonatal deaths are, in the main, preventable. They are caused by accidents, infectious disease, homicide, and other things in the home environment. Neonatal deaths, on the other hand, are usually linked to fatal congenital anomalies present before birth.

The implication is **not** that infant deaths are linked to race. Higher infant death rates are linked to poverty.

This is true around the globe. High IMR is a characteristic of societies of deprivation, no matter their racial makeup. Other characteristics are low levels of education, poor health care, lower socioeconomic status, and life-threatening environmental conditions. Many countries that have a high IMR also have heterogenous populations.

A multiracial society is our situation in the U.S. Blacks have an IMR twice that of whites, and Native American IMR is three times higher. This is one reason that the U.S. is in imminent danger of falling out of the "Top 20" of those industrialized nations with the lowest infant-death ratings in the world.

We can bring the focus closer to home. The steps from the U.S. to Shannon County in South Dakota reveal ever increasing mortality.

The Indian Health Service is divided into 12 units. Our Aberdeen office serves North Dakota, Montana, and South Dakota, and this unit has the highest IMR in the country. South Dakota has the highest IMR in the Aberdeen area: In 1986, IMR in North Dakota was 12.1, in Montana 15.5, and in South Dakota 31.

Shannon County population is approximately 93% Native American, or 23% of the total Native American population in the state. In 1987, 42% of all Native American infant deaths occurred in this county.

In comparison, Pennington County's total population is fully six times the size of Shannon. Pennington had nearly an identical number of infant deaths in 1987. Minnehaha

County is almost 10 times the size of Shannon, and had only a few more deaths.

When absolute numbers are translated to rate of deaths, the figures are even more revealing. In 1985, Minnehaha (with 10 times more population) recorded 10.7 deaths/1000 live births, Shannon had 36.1.

"Social indicators" show that IMR is linked to poverty. These are either actual characteristics of a population or are surrogates which allow us to translate an unmeasurable concept (which may be colored with judgmentalism and emotionalism) into measurable terms.

Social indicators which we've found linked with infant mortality among Native Americans are low levels of education, poverty, female-headed households, housing units without complete plumbing, divorce rate, and deaths from liver disease.

Missing from that list is an indicator we might have expected to appear: medical services, as measured by its surrogate, physician density. This may be a function of when the measurement was taken. Medical service on the reservation may be available, but doctors tend to spend only months on the reservation and then move on. Continuity is a problem.

A baby's health--and ultimate survival--is related to the age of the mother and her

Table 1. Infant death rates by race, 1977-1987. (rates per 1000 live births.)

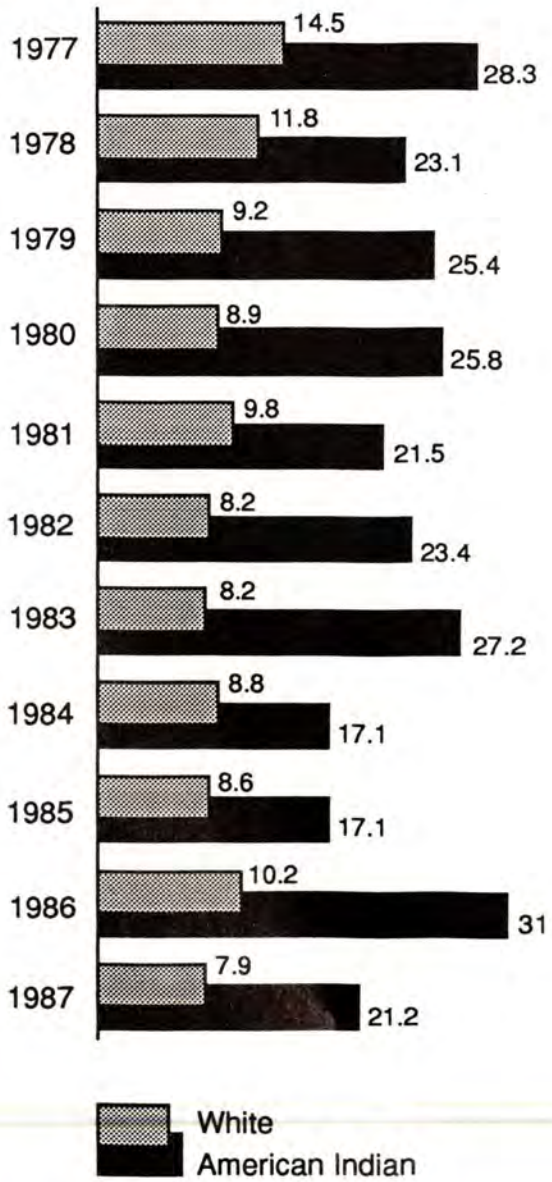
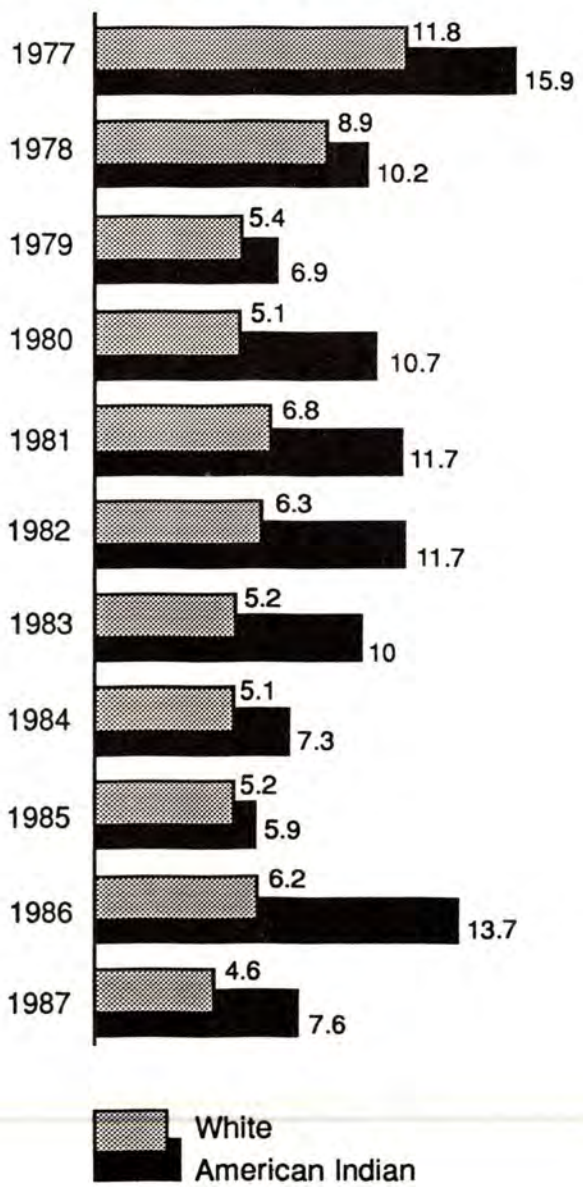


Table 2. Neonatal death rates by race, 1977-1987. (rates per 1000 live births.)



nutrition. Low-weight babies, more prone to die, are more often born to young mothers.

The Native American population is young. Pine Ridge has nearly about 12,300 residents, with close to 50% under the age of 19. High numbers of young people also fuel a momentum: more children having more children.

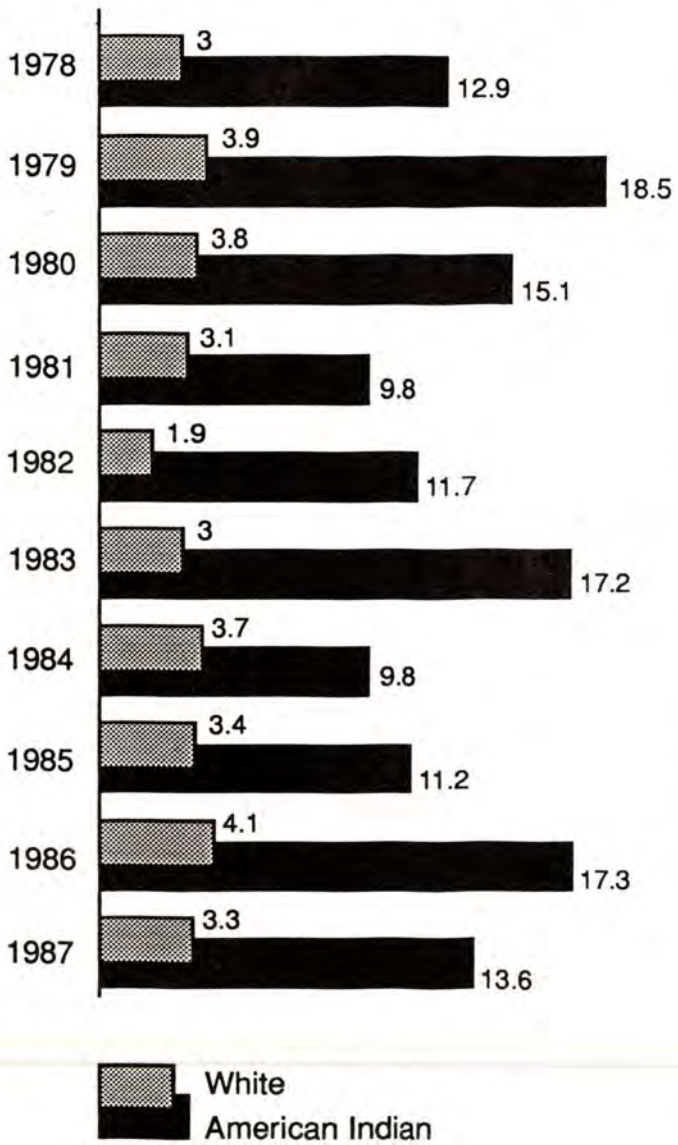
On South Dakota reservations, unemployment rates run up to 60 to 80%, up to 56% of the families live in poverty, and high-school dropout rates are as high as 60%.

Across the nation, the issue is one of poverty rather than race. Poverty is not having adequate food, not having adequate money to spend on health care and housing. Poverty breeds the physical and emotional stresses that lead to otherwise-preventable infant deaths.

Among all races, our poor population is growing and the middle-income group is shrinking.

" A baby's health -- and ultimate survival -- is related to the age of the mother and her nutrition. Low-weight babies, more prone to die, are more often born to young mothers. "

Table 3. Postneonatal death rates by race, 1978-1987. (rates per 1000 live births.)



Economic development is one way to provide a better life. It can increase income and education, improve and diversify a stable food supply, and provide technological advances in medicine and health.

However, economic development has less direct effect on the disadvantaged members of any population. Part of the reason other U.S. Native American reservations have lower IMR and higher incomes than those in South Dakota is that they have economic resources--control over coal, over oil, for example. South Dakota Native Americans have very few economic alternatives.

Whites and Native Americans alike have neglected the social implications of economic development for years. Project leaders for reservation development must realistically plan for a very young population, large households, a large percent of families headed by a single parent, improving but still low educational attainment, and low family incomes.

We cannot assume that certain human resources, skills, and abilities are already in place. A development project on a reservation that is purely "economic" will probably fail.

The base on which economic development is built must be human resource development.

It has three components. One is rehabilitation--increasing communication and leadership skills and improving the local

The tiospaye of Shannon County, the immediate and the extended family, welcomes and loves its children. Too often, however, the first year is too rigorous, and a high number of Native American infants die, at a rate three to five times that of white infants. Many of these deaths--from accidents, infectious diseases, and from other hazards in the home environment--could be prevented, but only if poverty is overcome first.

infrastructure of sewage and water systems; roads, bridges, and hospitals.

Another is alternatives--minimum wage laws, improved education, relocating people to jobs, for example. Women who have more education have alternatives to pregnancies. We know this from national data; we also know it from developing nations.

Third is a "safety net." It includes the traditional federal programs (foodstamps, commodities, ADC, and others), which help but do not alter the basic economy. These programs alone have never raised the standard of living in any part of the country.

Scaled industrialization and development of mainstreet economies on the reservation (the closest shopping area to Pine Ridge is in Nebraska) start with a human-resource base. The result is an economic development **package**.

This is not a package that can be wrapped up and delivered to the reservation from Washington or Pierre or from a church organization, private corporation, or developer. Nor can it be achieved wholly within the reservation itself.

The tribal colleges are a positive step in developing human resources. Educational attainment is increasing while important cultural values are being retained.

Being born into a Native American *tiospaye* has advantages. There is no question about whether the family, both immediate and extended, will take the child in and love it. The limited resources are stretched a little more, and the child is incorporated into the family.

This is the Year of Reconciliation. When we gather to discuss the important racial issues in the state, who will advocate for the infants? □

The writers are Dr. Linda Baer, associate professor, and Dr. Don Arwood, assistant professor in the Department of Rural Sociology; and Dr. Dana DeWitt, now at Culver-Stockton College in Missouri.

Director's Comments

continued from page 2.

management program that employs all the resources the farmer has at hand. If he has the time to respond and the labor to give, the recommendation can well be to cultivate instead of spray.

The systems approach of IPM makes chemicals only one option. When used, they must be safe, easily and quickly biodegradable, and economical. We will continue to provide information on optimum usage levels and safe handling procedures.

The systems approach, which deals with connections, makes all of us work harder. It may even require all of us to think more. We have to find the relationships between seemingly unrelated objects and processes. We must work in ways that are socially acceptable. That is a dimension that agricultural research has neglected in the recent past. It is being corrected.

The effort is worth making. With the systems approach, we will create an agriculture in the 90s that is both environmentally sustainable and economically sustainable. □

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